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must contain a neuromuscular mechanism sufficient for the activity of that part of its body.

The extended publication will appear in the *Journal of Experimental Zoölogy*.

THE BEHAVIOR OF SEA-ANEMONES

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The older students of sea-anemones, such as Gosse and von Lendenfeld, believed that these animals were endowed with mental traits not unlike those of man. Later workers, such as Loeb, Jordan, and others, regard these forms as finely adjusted machines devoid of psychic attributes. To discover something of the nervous nature of these animals two forms of their behavior were studied in detail, the appropriation of food, and general retraction. The work was carried out for the most part on *Metridium* and *Sagartia*.

In the appropriation of food, the parts chiefly concerned are the five following: the tentacular gland cells whereby the tentacles are rendered adhesive for food, the tentacular muscles by which the tentacles are pointed toward the mouth, the tentacular cilia by which the food is delivered from the tip of the tentacle to the mouth, the transverse mesenteric muscles whose action opens the mouth, and the oral cilia (lips and oesophagus) whose reversal in the presence of food carries this material into the digestive cavity of the sea-anemone. Of these five parts the mucous cells, the tentacular cilia, and the transverse mesenteric muscles are so uniform in their action that they need no further consideration. The oral cilia and the tentacular muscles on the other hand are much more open to variation and hence may serve to indicate to some extent the condition of the animal as a whole.

The oral cilia after having reversed their effective stroke in the presence of food a number of times, eventually cease to show this change, a condition supposed to be due to altered metabolism as a result of feeding. But this same cessation occurs when the oral membranes are cut from the animal and worked with separately. It is strictly local in its appearance and probably a pure fatigue effect.

The feeding movements of the tentacles, though also modified by fatigue, have been supposed to show changes of a more significant kind. If the tentacles on one side of the animal are much exercised, those of

the other side decrease in responsiveness. This change has also been supposed to be due to changed metabolism, but, since it appears quickly and before a general metabolic change can have occurred, it is probably that this too is the result of fatigue in that the food juices from the cavity of the tentacles transfuse the walls of these organs and thus reduce the sensitiveness of their exterior. Thus none of the elements in the feeding responses of sea-anemones imply that these animals are organisms that respond as firmly united wholes.

Retraction, whereby the more delicate parts of the sea-anemone are drawn in and covered, is the commonest protective act of this animal. Expansion is the reverse of retraction and puts the animal in form for full activity. Vigorous mechanical stimulation, most chemical stimuli, strong light, and high temperature induce retraction. The presence of food in the adjacent water, and water currents induce expansion. Oxygen as such seems to have little effect on these reactions.

Sagartia retracts when left dry by the tide and expands when it is again covered by the returning water. *Metridium* retracts in bright daylight and expands at night. The tidal rhythm of *Sagartia* and the nycthemeral rhythm of *Metridium* are not retained after the rhythmic stimulus is removed as has been claimed for European species by Bohn. There is also no evidence of an anticipatory reaction to the tides as maintained by Piéron. The retraction and expansion of sea-anemones, therefore, give no support to the view that these animals act under highly specialized nervous states.

The form of response which more than any other involves a sea-anemone as a whole is creeping. But even this form of activity can be accomplished by the pedal half of the animal. To repeated stimuli sea-anemones quickly adjust themselves rather by a process of adaptation than by one of exhaustion. Yet they have been found to show no evidence of associative capacity. They are animals whose momentary conditions are dependent upon the combined stimuli of their immediate surroundings rather than forms that are greatly influenced by their past history. And in consequence of this their unity is not of a pronounced type. They are more in the nature of a sum of parts than they are organic units such as we are familiar with among most of the higher animals.

The extended paper will be published in the *Journal of Experimental Zoölogy*.